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NPIC/R-136/64

February 1964

PHOTOGRAPHIC INTERPRETATION REPORT

ELECTRIC POWER GRID IN CENTRAL SIBERIA, USSR,

25X1D



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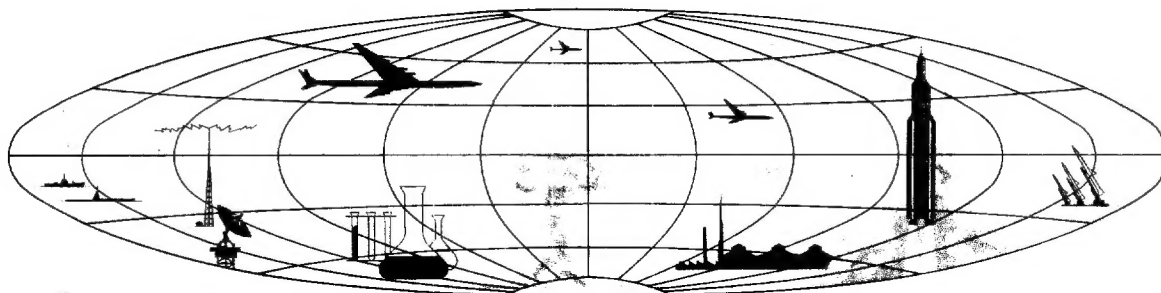
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PHOTOGRAPHIC INTERPRETATION REPORT

ELECTRIC POWER GRID
IN CENTRAL SIBERIA, USSR,

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SUMMARY

Continuing expansion of the power generating and transmitting capabilities of the central Siberian power grid, the eastern half of the Siberian power system, is evident from a survey of all available photography (from KEYHOLE

missions since [REDACTED] 25X1D
The photography indicates some modifications to published Soviet circuit diagrams for both installed and planned circuits.

INTRODUCTION

This report is in answer to a requirement for a photographic analysis of the availability of electric power in the central Siberian region of the USSR. It is the second in a planned series of photographic interpretation reports on the distribution of electric power in specific areas of the USSR, particularly where installations in an area are supplying power for the Soviet atomic energy program.*

The "Unified National Grid" planned by the Soviets to cover the European USSR also will extend through the Unified Siberian Power System (Yedinaya Energosistema SSR Sibiri) eastward to Lake Baykal. 1/ The electric power grid in central Siberia constitutes the eastern half of this unified Siberian power system (Figure 1). The central Siberian region as defined in this report extends north and south of the Trans-Siberian Railroad from 90 to 105 degrees east longitude and includes the major industrial centers of Krasnoyarsk on the Yenisey River and Irkutsk on the Angara River. The power grid of this region serves two atomic energy complexes in the vicinity of Krasnoyarsk (at Dodonovo 2/ and Zaozernyy 3/) and one in the vicinity of Irkutsk (at Angarsk).

This study is based on an examination of

all available KEYHOLE photography through [REDACTED] covering the region. No TAL- 25X1D
ENT photography or other aerial photography of the area before [REDACTED] is available. Published 25X1D
reports on the atomic energy complexes at Zaozernyy 3/ and Angarsk 4/ which were based in part on [REDACTED] photography may revise or up- 25X1D
date information presented in this report.

Although published Soviet circuit diagrams of the unified power system planned for Siberia were available for study, 1/ estimates of voltages and numbers of circuits for 500-kilovolt (kv) and 220-kv power lines are generally based on photographic interpretation confirming or revising other data. Estimates for 110-kv circuits are almost entirely based on photographic interpretation.

Atmospheric limitations precluded positive identifications of several electric power installations from photography. For example, all photography of the Krasnoyarsk area was obscured by clouds, haze, or smoke; similarly, the town of Cheremkhovo was obscured by smog. In some cases the plotting of electrical circuits is based on conjecture. The nature of such limiting conditions and the reliability of interpretations are noted on the circuit diagrams (Figures 2-5) and in Table 1 which provides descriptions of the region's power plants.

*The first report in this series is NPIC/R-26/63, Electric Power Grid in the North Ural Area of the USSR, Mar 63 (TOP SECRET CHESS RUFF/No Foreign Dissem).

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ELECTRIC POWER LINES

The central Siberian power grid will eventually be united to the rest of the national grid by extending the Angarsk-to-Nazarovo 500-kv power line west through Novosibirsk and Omsk (Figures 1-5) to the unified system of the European USSR. Within the grid area studied 220-kv power lines will effect major distribution and 110-kv lines paralleling the Trans-Siberian and East Siberian railroads will supply the electrified rail lines and communities along them.

500-kv Power Lines. The first 500-kv power line is currently under construction. When completed it will extend eastward from Nazarovo, the site of a major thermal power plant (Nazarovskaya KES), via Krasnoyarsk, Zaozernyy, and Tayshet, to Bratsk, the site of a large but uncompleted hydroelectric plant (Bratskaya GES), [REDACTED]

The section of this power line between Krasnoyarsk and Bratsk is under construction. In some stretches, particularly between Tayshet and Bratsk, the trace for the power line has not been cut and the point where the power line is to cross the Yenisey River in the vicinity of Krasnoyarsk could not be identified.

Other 500-kv lines are planned in the future to link three hydroelectric projects (Yeniseyskaya GES, Boguchanskaya GES, and Ust-Ilimskaya GES) and farther north outside the central Siberian grid to a fourth GES planned near Osinovo on the Yenisey River (Figure 1).

Large 500-kv switching yards were observed at Nazarovskaya KES and Bratskaya GES and 500-kv substations were identified at the atomic energy complexes at Zaozernyy and Angarsk. Substations for handling 500-kv power are planned to be located at Tayshet and Kansk. A possible 500-kv substation is identified at

Tayshet but one at Kansk has not been identified. A major substation for 220- and 110-kv lines is located at Tulun, but this substation apparently will be bypassed by the two Bratsk-Angarsk 500-kv lines. A site southeast of Tulun which was previously reported as a major substation under construction 5/ is re-identified as a cluster of heavy angle supports for 500-, 200-, and 110-kv circuits which change direction at this point. Similarly, a site near Cheremkhovo previously suspect as a substation is reinterpreted as containing only support towers (Figure 5). 5/

As of [REDACTED] 500-kv power could not be transmitted over any section of the 550-kv lines. Some 220-kv power was possibly being transmitted over the Nazarovo-Krasnoyarsk and Bratsk-Angarsk sections of the 500-kv line. One of the two planned single-circuit 500-kv power lines between Bratsk and Angarsk is completed and sections of the second power line were observed under construction as of [REDACTED] (Figures 4 and 5). 4/ While the 500-kv circuits of this line are not yet connected with a 500-kv switching yard at the Bratskaya GES, the completed circuit is temporarily tied into the adjacent 220-kv switching yard at the GES and probably into the 220-kv switching yard of the substation at the Angarsk Atomic Energy Complex.

220-kv Power Lines. In addition to 220-kv power being transmitted over the 500-kv power line (discussed above), single-circuit 220-kv power lines connect Bratsk and Irkutsk installations to the Angarsk installation (Figures 4 and 5). Additional 220-kv power lines are being constructed in the Angarsk/Irkutsk area (Figure 5) and power lines (probably 200-kv) are identified in the Nazarovo/Krasnoyarsk/Dodonovo area (Figures 2 and 3).

Railroad Power Lines. In the area studied, the Trans-Siberian Railroad is completely electrified between Achinsk, north of Nazarovo, and Slyudyanka along the railroad on the southwestern tip of Lake Baykal. A trace for a new power line is being prepared eastward from Slyudyanka along the railroad on the southern shore of the lake towards Ulan-Ude (Figure 1). The East Siberian Railroad, which branches from the Trans-Siberian Railroad at Tayshet and extends eastward via Bratsk to Lena near Ust-Kut on the Lena River, is also being electrified.

Photography indicates that the Trans-Siberian Railroad is served by a two-circuit 110-kv power line which generally parallels the railroad at a distance averaging about one mile. Both circuits are tied into a number of transformer substations which serve both the railroad and communities along the rail line (Fig-

ures 2-5). Between these substations, one of the two circuits is tied into two or three additional, intermediate substations for railroad use basically. In some cases, the names of substations are derived from the official Soviet railway schedule. 8/

The Trans-Siberian Railroad operates under alternating current (ac) between Achinsk and Zima and under direct current (dc) between Zima and Slyudyanka. Transformer substations for ac operations are sited about 35 to 40 miles apart; the transformer/rectifier substations for dc operations are sited approximately 25 miles apart. Substations for dc operations are usually larger in area than those for ac operations and include an ac/dc rectification building of standard size, measuring approximately [REDACTED] 6/ This building also houses an overhead catenary maintenance car.

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ELECTRIC POWER PLANTS

Exploitation of hydroelectric power resources of the Angara and upper Yenisey river basins is a major factor in the plan for the development of electric power in central Siberia. 1/ In particular, Soviet engineers appear to be planning to use the Angara River cascade of hydroelectric power plants as a primary power source and to use thermal power plants in the central Siberian area for providing supplementary power and supplying local power needs. This reliance on hydroelectric power contrasts with the usual Soviet practice of relying primarily on thermal generated power and using hydroelectric power for backup. Table 1 provides descriptions of the power plants.

HYDROELECTRIC POWER PLANTS

Of the hydroelectric power plants planned for the central Siberian region, only one (Irkutskaya GES on the Angara) was completed and

operational as of [REDACTED] and one (Bratskaya GES on the Angara) was partially completed and partially operational. Heavy construction had begun on one (Krasnoyarskaya GES on the Yenisey). A possible site for another (Boguchanskaya GES on the Angara) was identified.

Angara Cascade. Reliance on the Angara River as a power source is possible because the river's regime, unlike those of the Yenisey and other major Russian rivers, is characterized by an unusually uniform volume of flow throughout the year. The river's volume of flow is regulated by Lake Baykal which acts as a vast control reservoir. The level of the lake is being raised about 5 feet by the dam for the hydroelectric power plant at Irkutsk.

Photography of Bratskaya GES indicated that four turbogenerators are in operation and that the head of water is at two-thirds of the planned water level. The GES was esti-

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25X9 mated to be generating 460 megawatts (MW)
 25X9 of power. [REDACTED]

25X1D A possible site (58-25N 98-20E) for Bo-
 25X1D guchanskaya GES 7/ on the lower reaches of
 the Angara River was identified. Activity re-
 sembling geological investigation was observed.
 A rail line branching off the Trans-Siberian
 Railroad west of Tayshet at Reshoty was
 under construction northward toward the site
 (Figure 1). The rail line will cross the Biryusa
 River at Shelayevo where a bridge is under
 construction. Four of six steel spans for the
 bridge are in place. The right of way for the
 rail line has been cut northward since [REDACTED]
 [REDACTED] to a point (57-17N 97-48E) near
 the Chuna River. The exact site for a rail-
 road bridge to cross this river could not be
 identified. The rate of construction activity
 suggests that the rail line will reach the pos-
 sible site for Boguchanskaya GES sometime in
 1964. Heavy construction on the GES cannot
 begin until a rail line for transporting heavy
 construction equipment to the site is completed.

25X1D According to the Soviet press, the site for
 Ust-Ilimskaya GES has been selected, but the
 lack of photo coverage up to [REDACTED]
 precluded identification of the site. Photog-
 raphy does reveal preliminary construction for
 either a highway or a railroad extending north-
 ward from Novyy Bratsk in the probable direc-
 tion of the site.

Yenisey River Development. Soviet plans
 for exploiting the Yenisey River water resources
 include construction of the largest GES in cen-
 tral Siberia at a location in the vicinity of Yen-
 iseysk. The site for this GES has not been identi-
 fied on photography. The second largest, Kras-
 noyarskaya GES, is observed under construction
 on the Yenisey upstream from Krasnoyarsk.

Foundations are being constructed in the river
 bed; a rock and earth coffer dam projecting
 from the left bank of the gorge protects the
 site. The new community of Divnogorsk, loca-
 ted on the right bank, houses workers employed
 on the project. Three other hydroelectric pro-
 jects are planned for the upper reaches of the
 Yenisey in the vicinities of Minusinsk, Sayanskiy,
 and Chaa-Khol (Bolshaya Tuvinskaya GES).

THERMAL POWER PLANTS

Of major thermal electric power plants in
 the central Siberian region, four (at Nazarovo,
 Krasnoyarsk, Zaozernyy, and Angarsk) are at
 least in partial operation and a fifth major ther-
 mal power plant is planned for a location appar-
 ently near Azev. All power plants are located
 near the Trans-Siberian Railroad and are tied to
 the railroad power line by 110-kv circuits. The
 on-site power plants at Zaozernyy and Angarsk
 atomic energy complexes are TETS serving the
 complexes through internal 110-kv circuits and
 the power plant at Krasnoyarsk (Krasnoyarskaya
 KES) serves the Dodonovo atomic energy com-
 plex 2/ through 110-kv and probably 220-kv
 circuits. Two of these power plants--Kras-
 noyarskaya KES and the Angarsk on-site TETS--
 are complete (no indication of future expansion)
 and apparently in full operation.

The Nazarovo power plant and the one
 planned near Azev are also designated as GRES
 since they have regional functions. Only the
 Nazarovo power plant, which when completed
 will be the largest thermal power plant in the
 region, will be directly tied to a 500-kv power
 line. (The on-site TETS at the Zaozernyy and
 Angarsk atomic energy complexes are indirectly
 tied--through 110-kv circuits--to the 500-kv
 line which will service the complexes.) The
 Nazarovo power plant will also be tied into
 220-kv lines; the power plant at Krasnoyarsk is
 also apparently tied into 220-kv lines.

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At the Nazarovskaya KES in [REDACTED] one and possibly two turbogenerators were observed in operation and smoke was being emitted from one of the two completed stacks. An addition to the generator hall for at least a third turbogenerator appeared to be completed, and excavation was under way for foundations accommodating possibly three more turbogenerators and their boilers.

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The on-site thermal power plant at the Zaozernyy Atomic Energy Complex, although under construction at the end of [REDACTED] was generating some power at 110 kv from its turbogenerators in the eastern end of the plant. 3/ A new cooling tower is located between the power plant and the coal storage area.

Azeyanskaya GRES is planned for construction by 1975. Although its designation indicates a site near the village of Azey in the vicinity of Tulun and a site on the Trans-Siberian Railroad near Azey was previously suggested, 5/ no construction activity was observed in the Tulun/Azey area on later, more definitive stereophotography.

Other thermal power plants which may or may not be tied into the central Siberian power grid are relatively small. Most of them serve the local needs of communities and installations. Some may generate power for the Trans-Siberian Railroad. These small power plants are listed in Table 1 for information only. In most instances, no photographic interpretation was attempted.

Table 1. Description of Power Plants in Central Siberian Grid
(Boldface type indicates major power plant)

Location--nearest major town	Soviet Designation*	Coordinates	BE No	Voltages of Circuits Served by Power Plant, Other Observations (Date of photography & reliability)
Nazarovo	Nazarovskaya KES GRES	56-02N 90-21E	[REDACTED]	500 kv planned, probable 220 kv & 110 kv. Plant partially operating while construction continues. [REDACTED] photography, confirmed)
Yeniseysk (on Yenisey River near Abalakovo)	Yeniseyskaya GES (or Abalakovskaya GES)	58-08N 92-55E	[REDACTED]	500 kv planned. Site not identified. [REDACTED] photography)
Krasnoyarsk (on Yenisey River near Divnogorsk)	Krasnoyarskaya GES	55-56N 92-18E	[REDACTED]	500 & 110 kv planned. Dam foundation begun. [REDACTED] photography, confirmed)
Krasnoyarsk (Railroad Yards)	Not available--NA (TETS)	56-00N 92-50E	[REDACTED]	--
Krasnoyarsk (city)	NA (thermal)	56-00N 92-52E	[REDACTED]	--
Krasnoyarsk (Steel Plant)	NA (thermal)	56-00N 92-59E	[REDACTED]	--
Krasnoyarsk (East, Old)	NA (thermal)	56-00N 93-01E	[REDACTED]	--
Krasnoyarsk (East)	Krasnoyarskaya KES (formerly TETS)	56-01N 93-02E	[REDACTED]	Probable 220 kv & 110 kv (lines in city not identifiable). Plant in full operation. [REDACTED] photography, confirmed)
Zaozernyy (Atomic Energy Complex)	NA (TETS)	56-09N 94-29E	[REDACTED]	110 kv. Plant partially operating while construction continues. [REDACTED] photography, probable)
Zaozernyy (town)	NA (TETS)	55-58N 94-42E	[REDACTED]	--
Kansk	NA (thermal)	56-12N 95-42E	[REDACTED]	--
Boguchany (on Angara River near Goltyavino)	Boguchanskaya GES	58-25N 98-20E	[REDACTED]	Planned voltages not known. Possible site identified. Heavy construction not begun. ([REDACTED] photography)
Azey	Azeyanskaya KES GRES	--	[REDACTED]	Planned voltages not known. Site not identified. [REDACTED] photography)
Kuznetsova-Vikhoreva	NA (thermal)	56-05N 101-16	[REDACTED]	--

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Table 1: (Continued)

Location--nearest major town	Soviet Designation*	Coordinates	BE No	Voltages of Circuits Served by Power Plant, Other Observations (Date of photography & reliability)
Bratsk (on Angara River at Padun near Novyy Bratsk)	Bratskaya GES	56-18N 101-47E		500, 200, & 110 kv. Partial operation while construction continued. [redacted] photography, confirmed)
Ilimsk (on Ilim River at Simakhina near mouth on Angara)	Ust-Ilimskaya GES	57-45N 102-35E		500 kv planned. Site not identified. (Photography not available)
Cheremkhovo	NA (TETS)	53-08N 103-08E		--
Cheremkhovo (East)	NA (thermal)	53-08N 103-11E		--
Makaryevo (Battery Plant)	NA (TETS)	53-06N 103-21E		--
Makaryevo (New)	NA (thermal)	53-07N 103-24E		--
Usolye-Sibirskoye (New)	NA (TETS)	52-48N 103-36E		Probably 110 kv. Area obscured by clouds. [redacted] photography)
Usolye-Sibirskoye (Salt Plant)	NA (thermal)	52-45N 103-40E		--
Usolye-Sibirskoye (Machine Shop)	NA (thermal)	52-45N 103-41E		--
Usolye-Sibirskoye (Foundry)	NA (thermal)	52-44N 103-41E		--
Telma (on Yenisey River)	Telminskaya GES	52-48N 103-45E		Planned voltages not known. Site not identified. [redacted] photography)
Angarsk (Combine 16)	Angarskaya TETS-1	52-36N 103-55E		Possibly 110 kv. Plant was cloud covered, only stacks were visible. [redacted] photography, possible)
Angarsk (Petroleum Refinery)	Angarskaya TETS	52-32N 103-56E		Voltages not determined. Plant was cloud covered. [redacted] photography)
Angarsk (Atomic Energy Complex)	NA (TETS)	52-39N 103-59E		110 kv. On-site plant serves atomic energy complex. [redacted] photography, confirmed)
Angarsk near Sukhovskaya	NA (TETS)	52-26N 104-00E		--
Angarsk (near Sukhovskaya on Angara River)	Sukhovskaya GES	52-30N 103-58E		Planned voltages not known. Site not identified. [redacted] photography, possible)
Irkutsk (IAZ--Irkutsk Aluminum Plant, at Shelekhov)	Irkutskaya TETS IAZ	52-14N 104-07E		Voltages not determined. Plant not observed. [redacted] photography, possible)
Irkutsk	(thermal plant named Stalin)	52-20N 104-13E		--
Irkutsk	(thermal plant named Lenin)	52-20N 104-14E		--
Irkutsk (city)	Irkutskaya TETS-2	52-17N 104-16E		Voltages not determined. Plant not observed. [redacted] photography)
Irkutsk (Heavy Equipment Plant Kuybyshev 222)	NA (TETS)	52-17N 104-18E		--
Irkutsk (on Angara River)	Irkutskaya GES	52-14N 104-18E		220 & 110 kv. Plant in full operation. [redacted] photography, confirmed)
Kultuk (possibly on Irkut River)	NA (GES)	NA		Site not identified.
Chan-Khol (on Yenisey River)	Bolshaya Tuvinskaya GES	NA		Site not identified.
Minusinsk (on Yenisey River)	NA (GES)	NA		Site not identified.
Chernogorsk	NA (thermal)	53-49N 91-17E		--
Abakan	NA (thermal)	53-43N 91-26E		--
Sayanskiy (on Yenisey River)	NA (GES)	NA		Site not identified.

*In Soviet terminology, a hydroelectric plant is designated GES, but thermal electric power plants are designated variously: TETS--a heat and thermal power plant; KES--a condensating thermal power plant which uses all of its steam for power production; and GRES--a regional thermal power plant which may be a TETS or a KES.

Index To Power Installations

1. Nazarovskaya KES
2. Krasnoyarskaya GES
3. Krasnoyarskaya KES
4. Dodonovo, 220-kv substation
5. Zaozernyy on-site TETS
6. Zaozernyy, 500-kv substation
7. Kanak, 500-kv substation
8. Tayshet, 500-kv substation
9. Boguchanskaya GES
10. Ust-Ilimskaya GES
11. Bratskaya GES
12. Tulun, 220-kv substation
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15. Angarsk, 500- & 220-kv substation
16. Angarsk on-site TETS
17. Sukhovskaya GES
18. Irkutskaya GES
19. GES near Kultuk
20. Bolshaya Tuvinskaya GES
21. GES near Sayanskiy
22. GES near Minusinsk
23. Yeniseyskaya GES

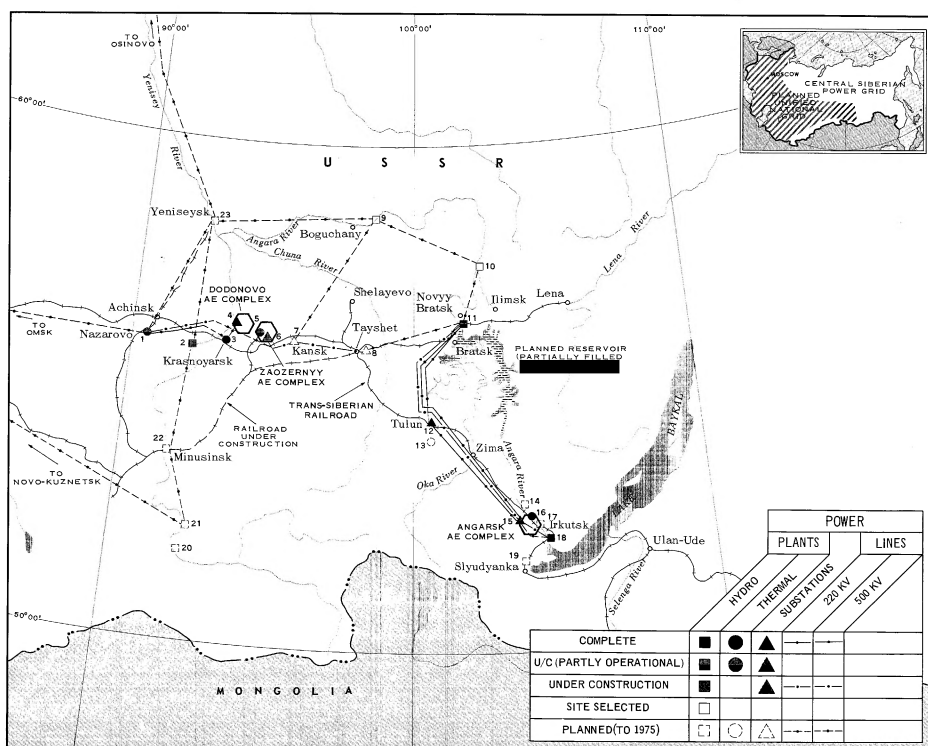


FIGURE 1. LOCATION OF CENTRAL SIBERIAN POWER GRID. Only substations handling 500-kv and 220-kv power are shown. Lines of 110-kv are not shown.

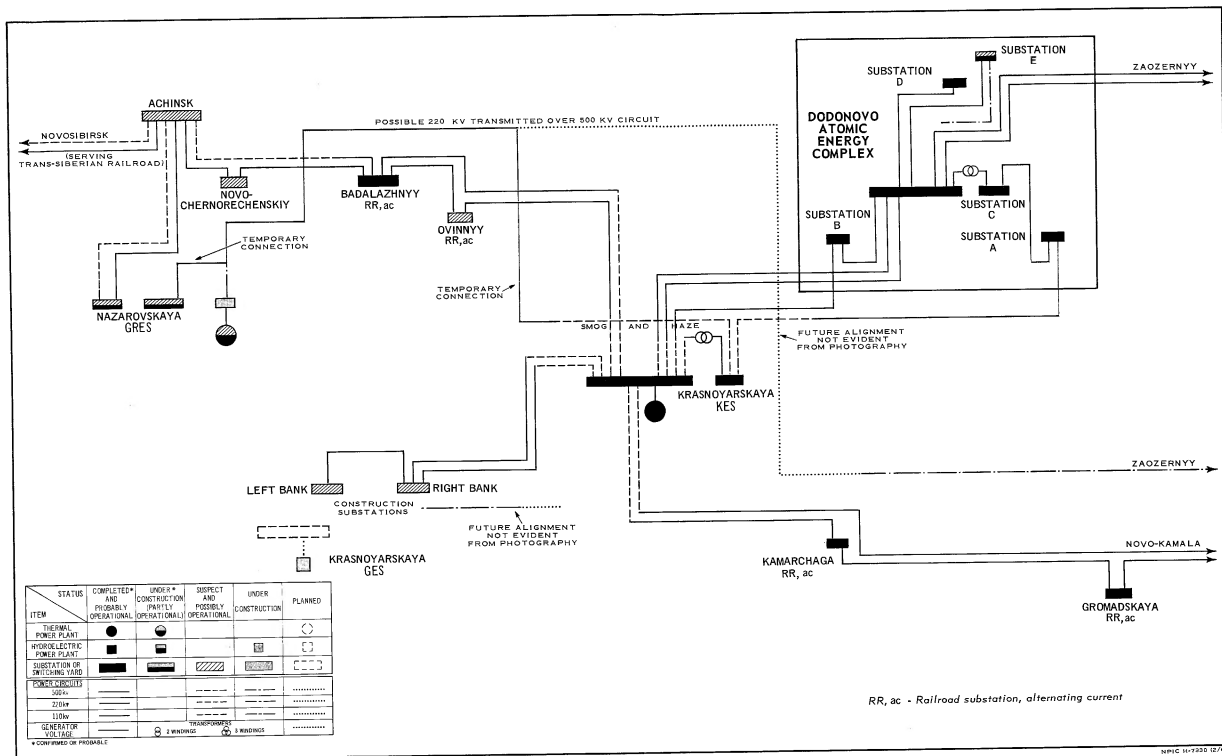


FIGURE 2. WESTERN SECTION OF CENTRAL SIBERIAN POWER GRID. Planned connections outside the grid are not shown.

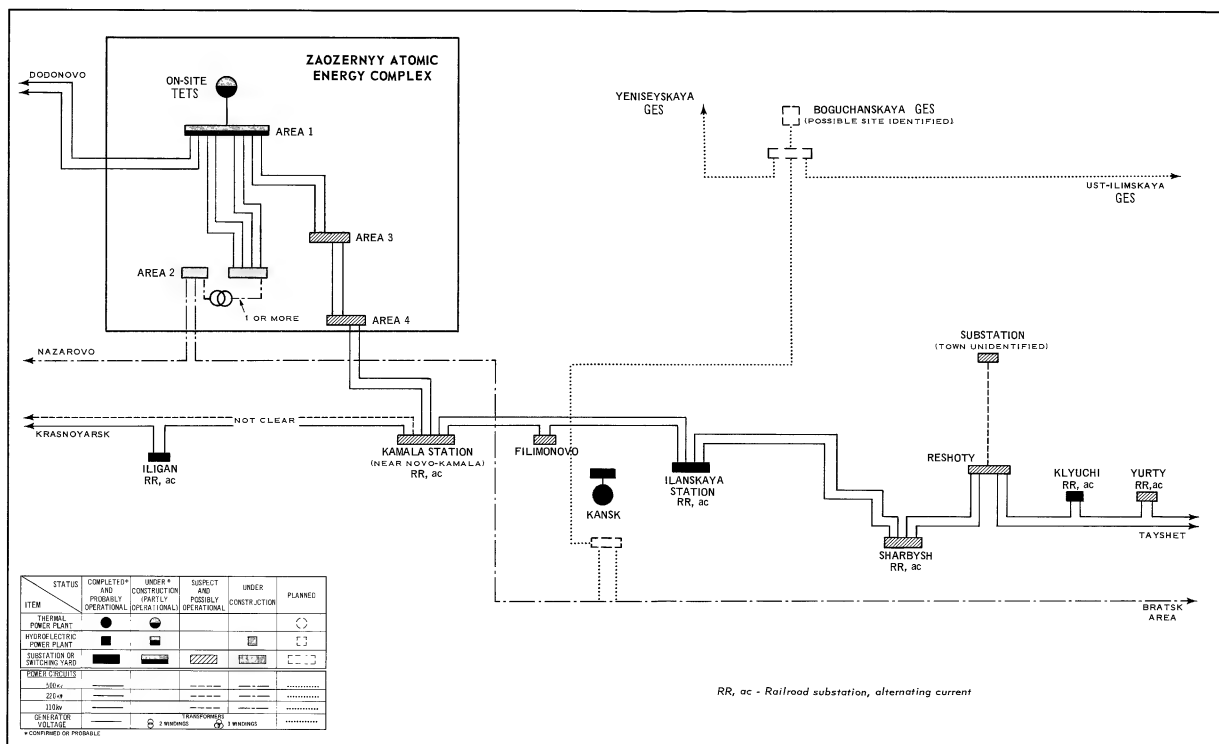


FIGURE 3. WEST-CENTRAL SECTION OF CENTRAL SIBERIAN POWER GRID. Planned connections outside the grid are not shown.

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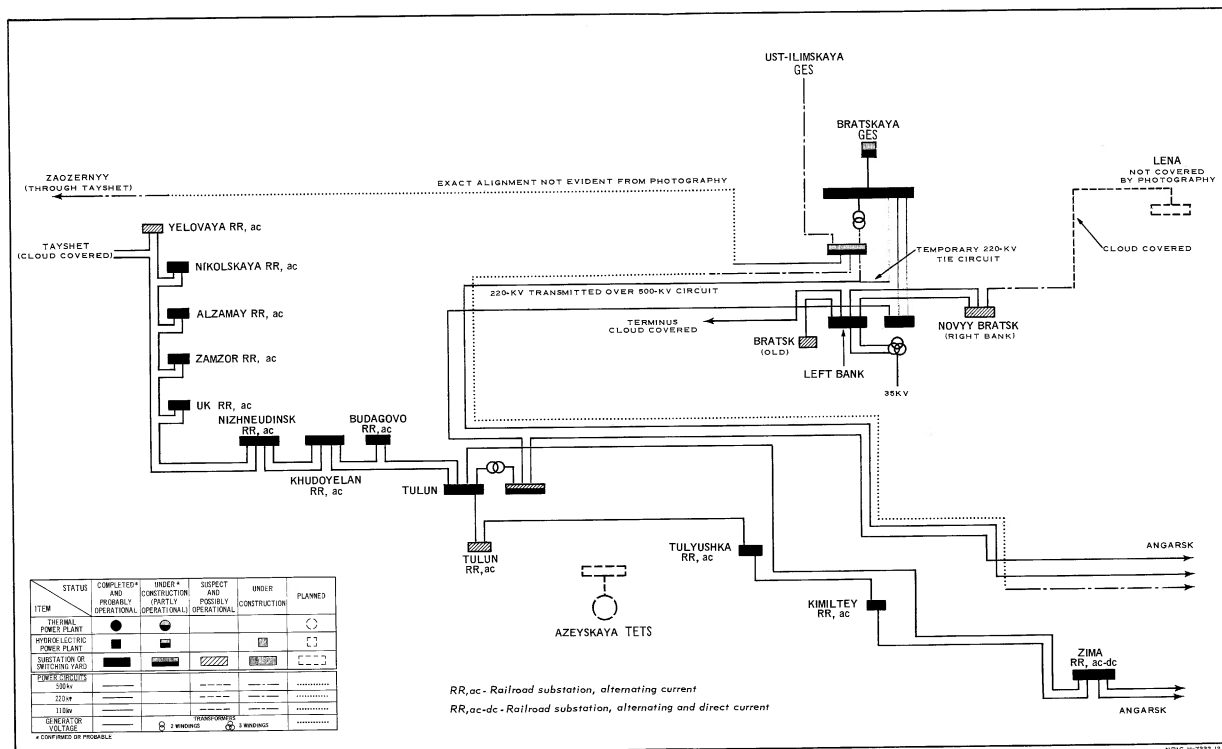


FIGURE 4. EAST-CENTRAL SECTION OF CENTRAL SIBERIAN POWER GRID. Planned connections outside the grid are not shown.

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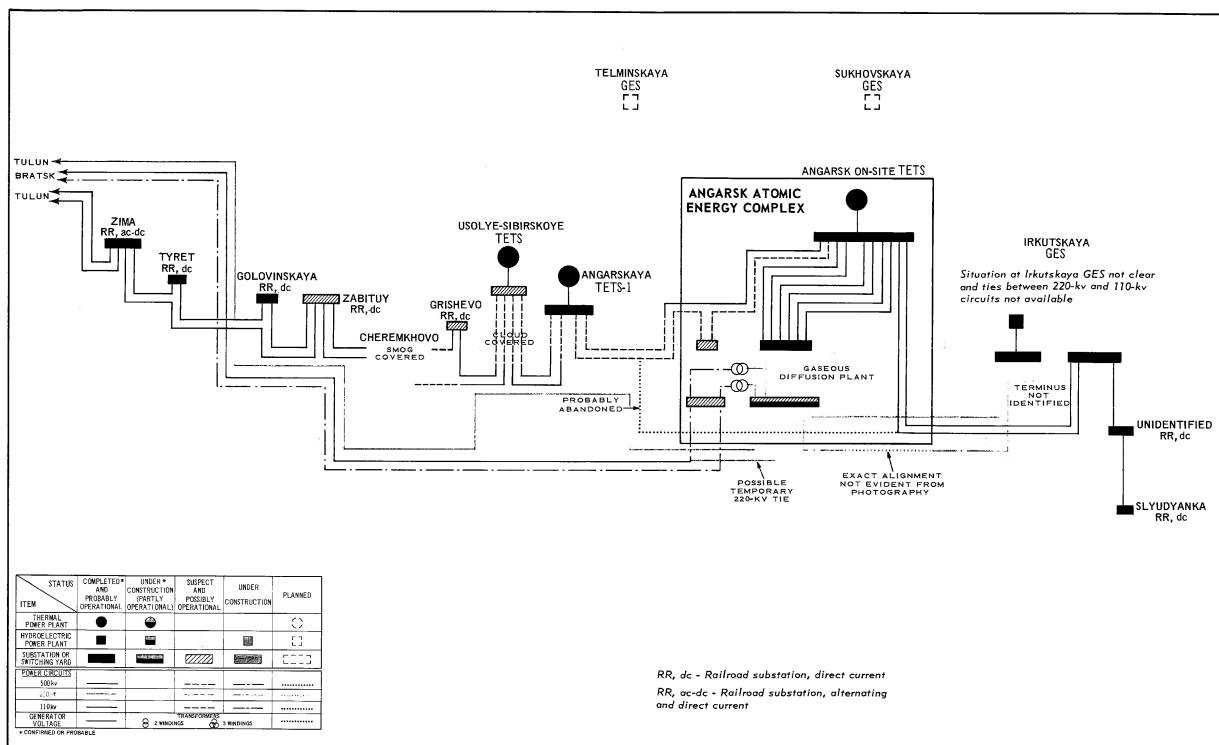


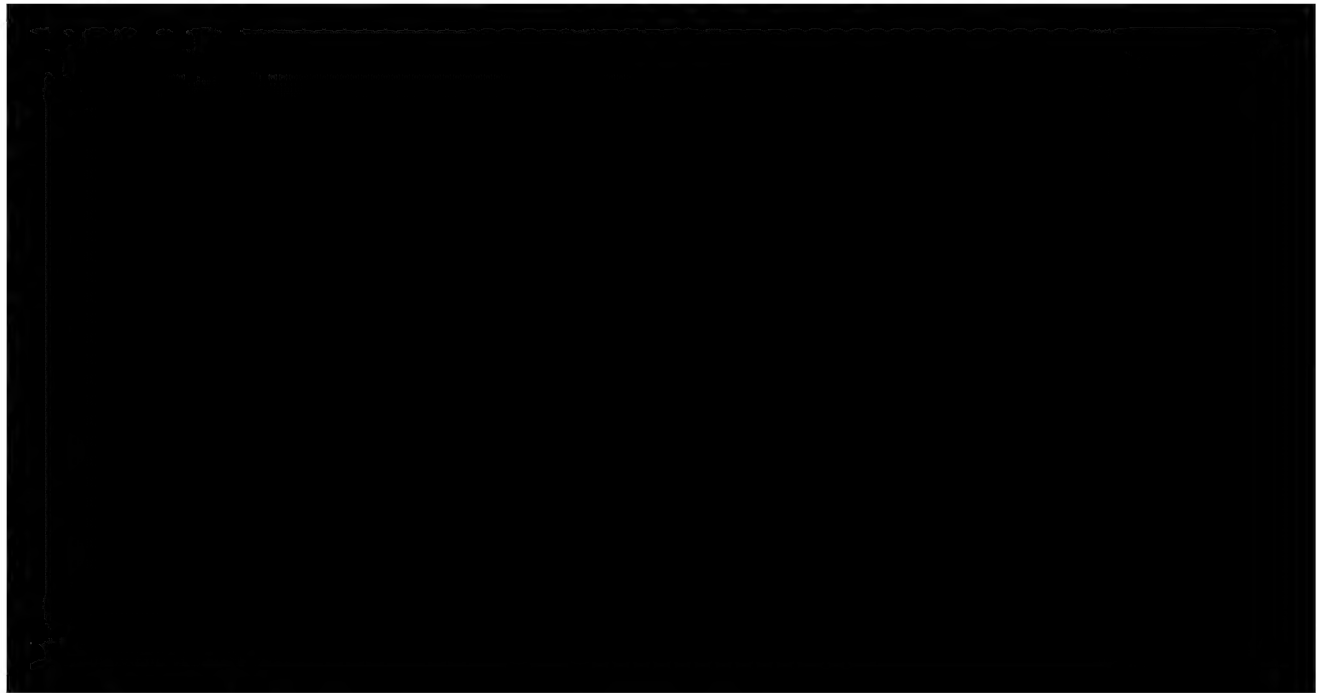
FIGURE 5. SOUTHEASTERN SECTION OF CENTRAL SIBERIAN POWER GRID. Planned connections outside the grid are not shown.

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